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NATIONAL DAM SAFETY PROGRAM CARGILL RESERVOIR DAM (NY 00086) HU--ETC(U)
SEP 78 J J WILLIAMS DACW51-78-C-0035

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(1) HUDSON RIVER VALLEY

CARGILL BROOK, PUTNAM COUNTY

NEW YORK

(2) # CARGILL RESERVOIR DAM

(5) ## PHASE I INSPECTION REPORT

(1) ## NATIONAL DAM SAFETY PROGRAM

(9) NY 00086

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CONTRACT NO. DACW 51-78-C-0035

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

AUGUST 1978

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Hudson River Valley, Cargill Brook,
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Phase I Inspection Report,

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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Putnam County
Cargill Brook
Cargill Reservoir Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Cargill Reservoir Dam was judged to be safe, although further investiagtion and maintenance actions were recommended.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

HUDSON RIVER BASIN

Name of Dam: Cargill Reservoir Dam
County and State: Putnam County, New York
Inventory Number: NY00086

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien & Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: August 18, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Cargill Reservoir Dam
(formerly Beacon Reservoir Dam)

State Located: New York
County Located: Putnam
Stream: Cargill Brook
Date of Inspection: July 18, 1978

ASSESSMENT OF GENERAL CONDITIONS

Cargill Reservoir Dam (formerly Beacon Reservoir Dam) is an earth embankment with concrete corewall, and is approximately 650 feet long and 75 feet high at its maximum section. An ungated ogee spillway is located at the south abutment.

A dense growth of trees and brush cover the upstream and downstream slopes; maintenance at the site appears to be minimal. The trees and brush should be cut near the ground surface and a further investigation made to determine the extent of the root systems before remedial measures can be recommended.

A depression was observed in the dam crest and discolored seepage was noted at or near the downstream toe. After the dense vegetation is cut, it may be possible to detect the source of these potential problem areas.

Examination of the results of the hydrologic/hydraulic analyses indicated that the dam would be overtopped by all floods exceeding approximately 81 percent of the Probable Maximum Flood.

The stability of the concrete spillway is largely dependent upon the type and strength of the contact area between the concrete and the foundation rock. The section geometry, depth of key, and anchorage, if any, should be determined to provide adequate information for a complete stability analysis of the structure.

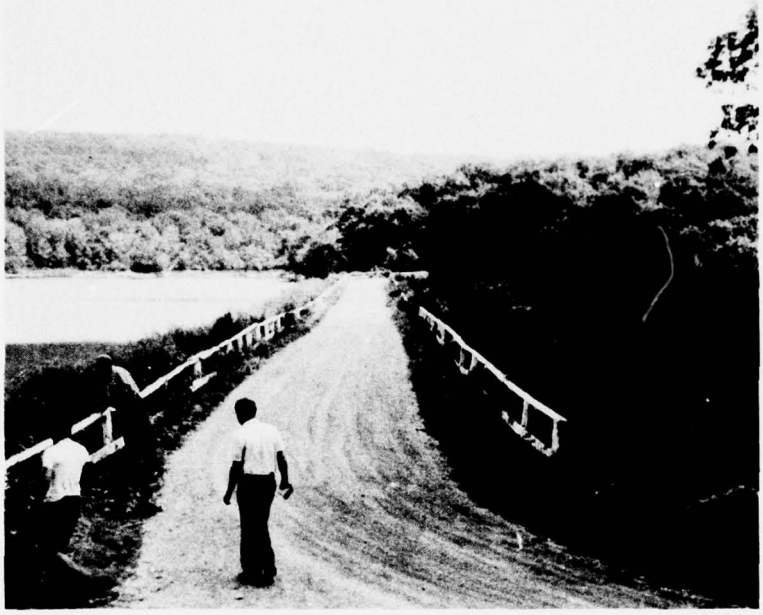
The spillway discharge channel should be excavated to provide sufficient capacity to prevent overtopping of the spillway training wall.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams, P.E.
Vice President

Approved by: _____
Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 29 September 78



OVERALL VIEW OF DAM

SPILLWAY CREST

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM CARGILL RESERVOIR DAM ID# NY00086

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract #1467.021 between O'Brien & Gere Engineers, Inc., and the New York State Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural and hydraulic conditions of the Cargill Reservoir Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - (from information supplied by the City of Beacon, Department of Public Works.) Cargill Reservoir Dam is an earth embankment with a reinforced concrete corewall extending into the foundation materials. The dam has a maximum height of about 75 feet, is approximately 650 feet long and has a top width of about 10 feet. The upstream slope is $2\frac{1}{2}$ horizontal to 1 vertical, and is protected by a 12 inch layer of riprap; the downstream slope is 2 horizontal to 1 vertical.

An ungated, ogee-shaped, concrete weir has been constructed on bedrock at the south abutment. The spillway approach is spanned by a wooden bridge supported on two concrete piers. A 4 foot high concrete training wall is located along the north side of the spillway channel and extends for a distance of approximately 180 feet downstream.

A valve chamber is located at the upstream edge of the crest of the dam near the center of the embankment. The original outlet works for Cargill Reservoir consisted of a 20 inch diameter gated blow-off pipe originating in a lower intake chamber at Elevation 825 and a 10 inch diameter water supply conduit which was designed to draw water from the upper level intake chamber at Elevation 855. According to Mr. Mark Giordano, Water Supply Superintendent, City

of Beacon, the 10 inch pipe is no longer in service. Mr. Giordano stated that the blow-off pipe has been tapped immediately downstream of the embankment and is connected to a 10 inch diameter water supply conduit. This pipe continues ½ mile downstream where water is discharged into a holding tank.

The Dam and Appurtenant Structures are owned by the City of Beacon and are operated by the Department of Public Works. The primary purpose of the reservoir is for the impoundment of a treated water supply for the City of Beacon, NY.

b. Size Classification - Cargill Reservoir was designed for a storage volume of 165 million gallons (505 acre-feet) at the maximum operating pool elevation of 880 feet mean sea level (MSL). The maximum height of the dam is 75 feet. The structure is in the intermediate size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

c. Hazard Classification - The valley downstream of the dam contains about 20 private residences within one mile of the structure. The topography downstream of the embankment is such that flood waters would be directed towards these homes resulting in possible loss of many lives and significant property damage. Therefore, the structure is in the high hazard category, as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA - (from information supplied by the City of Beacon, Department of Public Works.)

a. Drainage Area - The drainage area of Cargill Reservoir is about 0.75 square miles and the surface area of the reservoir is about 0.04 square miles.

b. Discharges - Discharge from Cargill Reservoir is accomplished through operation of a 20 inch gate valve downstream of the dam. Mr. Giordano, Water Supply Superintendent, stated that the water supply capacity is about 500 gpm. According to Mr. Giordano, the maximum reservoir elevation of record was 6 inches over the spillway (no date given); this corresponds to a discharge of approximately 75 cfs. The spillway discharge capacity is approximately 2400 cfs.

c. Reservoir Data

Maximum Operating Pool (Reservoir at Elevation 880)
Length - 1700 feet
Area - 25 acres
Volume - 505 acre-feet

Top of Dam (Elevation 885)
Length - 1750 feet
Area - 32 acres
Volume - 648 acre-feet

Maximum Pool (PMF - Elevation 885.1)
Length - 1750 feet
Area - 32 acres
Volume - 652 acre-feet

d. Dam Data

Type - earth embankment
Top elevation - 885 feet
Original ground elevation - 820 feet
Length - 650 feet
Top width - 10 feet
Side slope - upstream slope $2\frac{1}{2}$:1, downstream slope 2:1
Zoning - none
Impervious core - concrete corewall 3 feet wide at base narrowing to 1 foot at crest
Cutoff - bottom of corewall extends into foundation; about 55 feet of steel sheet pile used on north abutment
Grout curtain - none

e. Spillway

Type - concrete overflow
Length of weir - 60 feet
Crest elevation - 880 feet
Height - 5 feet (maximum)
Downstream channel - poorly defined channel with a concrete training wall extension to protect the embankment.

f. Engineering Data - The information available for review of Cargill Reservoir Dam included:

1) Contract Drawings, Sheets 2-4, May 22, 1930

2) Dam Construction Application, May 27, 1930

3) Drawing of 20 inch C.I.P. Reconstruction

4) Correspondence Describing Post-Construction Difficulties, 1932

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - A 20 inch diameter blow-off pipe, available for drawdown of Cargill Reservoir, is controlled by means of a gate valve located in the vault at the crest of the dam and another valve located downstream of the structure. According to Mr. Mark Giordano, Water Supply Superintendent, City of Beacon, the 20 inch gate valve in the vault is always open and the 20 inch valve downstream of the 10 inch tap is always closed. City personnel are on-site twice daily to record and adjust discharge from the water supply conduit.

b. Maintenance of Dam and Operating Facilities - According to Mr. Giordano, maintenance is performed on an "as needed" basis.

c. Flood Warning System - No flood warning system is in effect for Cargill Reservoir Dam.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of the Cargill Reservoir Dam took place on July 18, 1978. The reservoir water surface elevation was approximately 875 feet MSL during the inspection. No underwater areas were inspected.

b. Dam - The upstream slope is covered with brush, as well as a large number of twigs and branches, apparently the result of previous cutting operations. Inspection of the riprap revealed no evidence of displacement or erosion of the cobble-size stones. A wooden fence has been constructed on top of a concrete wall which may be an extension of the corewall. The crest of the embankment is depressed for a distance of about 30 feet north and south of the valve chamber. The downstream slope is heavily overgrown with brush and trees as tall as 35 feet. The exact location of the toe of the downstream slope could not be determined during the inspection since the vegetation growing on the downstream slope is indistinguishable from the forest surrounding the reservoir; the visible topsoil on the embankment matches the overburden on the valley slopes. Areas of flow were evident near the center of the stream valley in the vicinity of the downstream toe. These may be springs or seepage drains that are not shown on the plans. An orange-brown stain on the ground surface and a flow measuring weir is evident at each area. Clear water is discharging from a partially buried pipe near the supposed location of the downstream toe near the center of the dam.

c. Appurtenances - According to Mr. Giordano, Water Supply Superintendent, City of Beacon, the gate valves in the valve chamber are in the open position and have not been operated for several years. The control valves downstream of the embankment were neither inspected nor operated at the time of inspection because the valve box covers were bolted down.

The spillway approach channel is partially clogged with brush and debris. The concrete wingwalls, bridge pier and ogee weir appear to be in good condition. The weir is constructed about 25 feet downstream of the bridge and extends from the training wall to the south abutment. The weir is approximately 5 feet high at the maximum section, with a base width of approximately 8 feet. This spillway configuration is not as shown on the original contract drawings. There is no well-defined outlet channel downstream of the spillway crest. The concrete training wall protecting the embankment from the spillway flow is in fair condition.

d. Downstream Channel - The downstream channel consists of the natural valley cut by Cargill Brook.

e. Reservoir Area - The natural ground surrounding the reservoir has a moderate to steep slope and is well covered with trees and brush.

SECTION 3 - HYDROLOGY/HYDRAULICS

According to the Recommended Guidelines for Safety Inspection of Dams, the Spillway Design Flood is the Probable Maximum Flood (PMF). The PMF was calculated from the 6 hour Probable Maximum Precipitation, using a loss rate of 0.1 inches per hour. The flood hydrograph was developed from a Soil Conservation Service triangular unit hydrograph based on basin parameters. Flood routing through the reservoir was performed assuming the gated outlets to be closed and the starting water surface at the spillway crest. The peak inflow and outflow rates were calculated as 3507 cfs and 3420 cfs respectively. This discharge would cause overtopping of the dam by about 2 inches. The peak inflow and outflow rates for one-half of the PMF were calculated as 1750 cfs and 1430 cfs respectively. The maximum nonovertopping discharge is approximately 2400 cfs; this corresponds to about 81 percent of the PMF. The spillway is inadequate for discharge of the PMF, but according to Engineering Technical Letter 1110-2-234, the spillway is not "seriously inadequate."

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATIONS AND DATA REVIEW - Two observations were made during the visual inspection of Cargill Reservoir Dam which suggest the existence of unstable conditions. A depression in the dam crest indicates the possible loss of material from the embankment due to fines migration, and the discolored seepage noted at several locations at or near the downstream toe indicate that uncontrolled seepage paths have developed through the embankment or foundation. According to Mr. Giordano, the depression in the dam crest has been in existence for a number of years. According to a letter dated August 17, 1932, which is included in the appendix, "... a 50 foot interval of the embankment at center of dam has been built up 3 times, each time to allow for sinkage (possibly settlement compaction) of 6 inches ..."

The seepage condition at the downstream toe, which may be associated with the depression, has been in existence since 1932 according to correspondence between State and Local Officials. The letters contain information describing weirs constructed to measure the seepage, the depth of flow over the weirs and the "brown precipitate" collected on the bottom of the collection basins.

The upstream and downstream slopes are overgrown with trees, brush and vegetation. The roots of the large trees on the slopes may be providing seepage paths which could lead to future piping. These trees could be uprooted by high winds removing large amounts of material from the embankment.

Insufficient information was available for performing a stability analysis of the overflow spillway. The spillway differs in location and cross-section geometry from information included in the design drawings. During the field investigation, no determination could be made of a possible extension of the concrete structure below the ground surface. Unless the structure is keyed and anchored to the rock foundation, structural instability may develop during extreme loading conditions.

4.2 GEOLOGY AND SEISMIC STABILITY - Cargill Reservoir Dam is located in the New England Uplands physiographic province. The rocks in this province consist of both metamorphic and igneous types in varied and complex structure. The embankment was constructed across the Cargill Brook and is founded upon both the unconsolidated alluvial deposits in the stream valley and outcroppings of the local bedrock. As evidenced during the field inspection and on the as-built drawings, the southern sections of the structure and the overflow weir are founded upon the Precambrian gneissic units.

Lineaments shown on the Geologic Map of New York, possibly associated with the Ramapo fault system, exist in the vicinity of Cargill Reservoir. Although renewed seismic activity has been recorded along this system in recent years, no earthquakes of any considerable magnitude have been recorded within 50 miles of the structure. The dam is located in Seismic Risk Zone 1 of the Seismic Zone Map of Contiguous States and it appears that static stability conditions are satisfactory.

SECTION 5 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

5.1 ASSESSMENT - The visual inspection revealed a significant lack of maintenance at the Cargill Reservoir Dam. Both the upstream and downstream slopes are overgrown with trees and brush. The root systems of large trees may have a deleterious effect upon the compacted embankment and provide seepage paths that may extend a considerable distance into the embankment. High winds could uproot the trees and remove large portions of the embankment.

Seepage and discoloration were noted at several locations near the downstream toe. Vertical misalignment of the curbwall at the crest of the dam (apparently an extension of the corewall) is an indication of possible differential settlement. The depression in the dam crest indicates the possible loss of material from the embankment.

No information was made available concerning the design of the overflow spillway as constructed. The spillway may be unstable for extreme loading conditions if the structure is not keyed and anchored to the foundation.

The topography south of the concrete training wall is such that elevations along the spillway channel often exceed the top elevation of the training wall. Therefore, discharge is frequently directed towards the training wall. The available channel cross-section at some locations along the wall is very small; significant discharge could undermine or overtop the wall endangering the adjacent embankment.

Examination of the results of the hydrologic/hydraulic analyses indicated that the dam would be overtopped by all floods exceeding approximately 81 percent of the Probable Maximum Flood.

5.2 RECOMMENDATIONS/REMEDIAL MEASURES - The trees and brush growing on the embankment slopes should be cut to root level and removed from the surface of the structure. A further investigation should be made to determine the extent of the root systems before remedial measures can be recommended. After removal of the trees, additional inspections should be conducted to determine the source of seepage and discoloration noted near the downstream toe. The need for a subsurface exploration program, including piezometer installations, should be assessed at that time.

The spillway section geometry, depth of key, and anchorage, if any, should be determined to provide adequate information for a complete stability analysis of the structure.

The spillway discharge channel should be excavated, or the training wall heightened, to provide sufficient discharge capacity to eliminate overtopping and undermining of the spillway training wall. The 20 inch manual gate valve in the valve chamber should be operated to insure that it is in good working order.

FIGURES

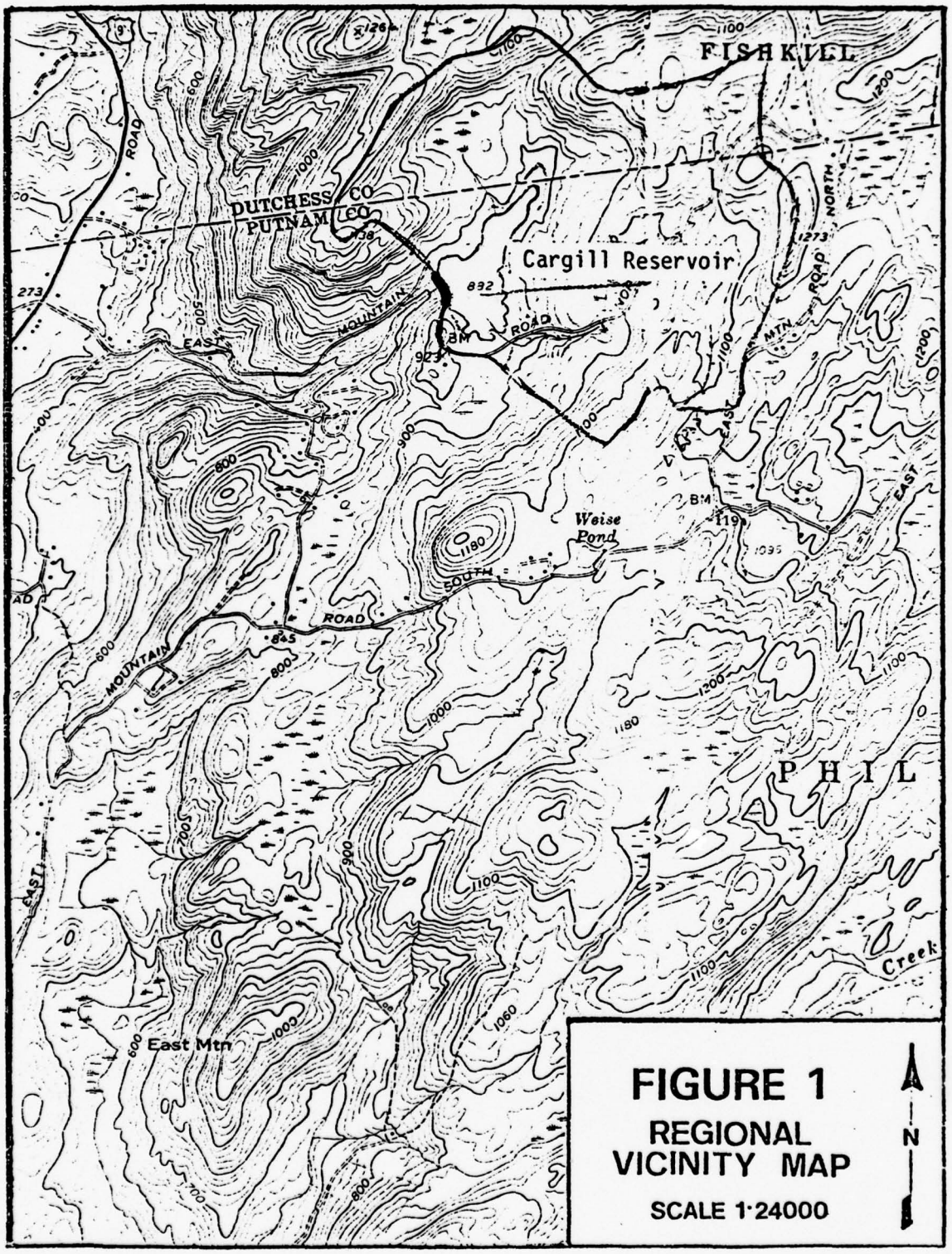


FIGURE 1

REGIONAL VICINITY MAP

SCALE 1·24000

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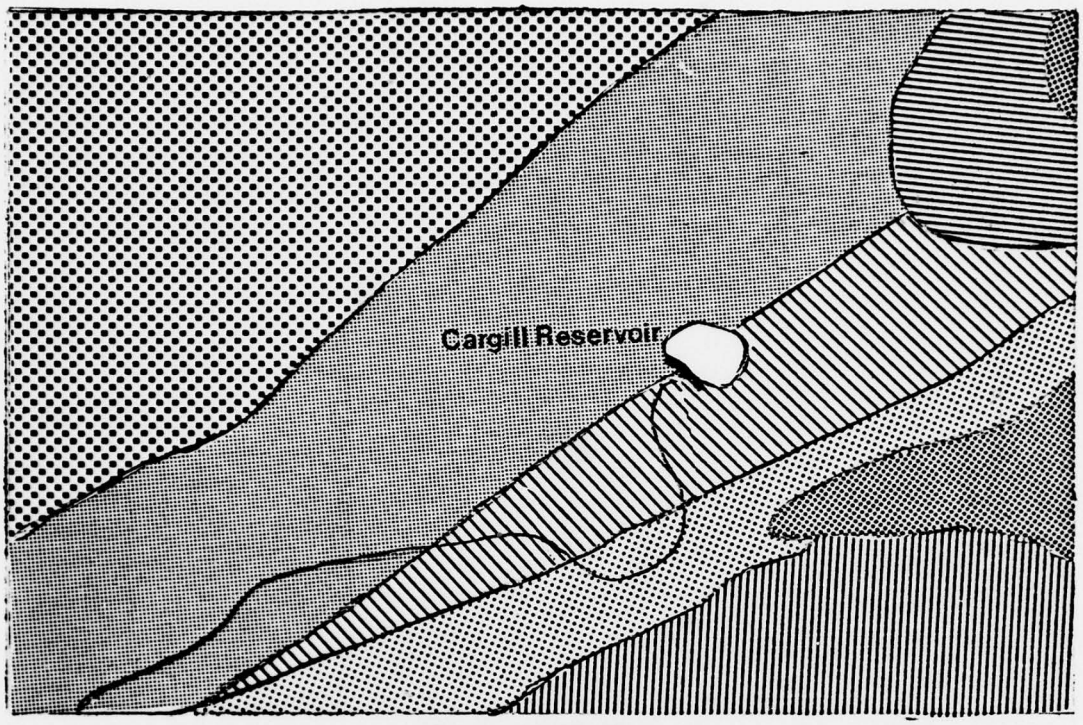


Scale 1:50,000

qtlg - leucogranitic gneiss, interlayered quartzite

bqpc - biotite, quartz, plagioclase paragneiss

qtcs - non-rusty paragneiss

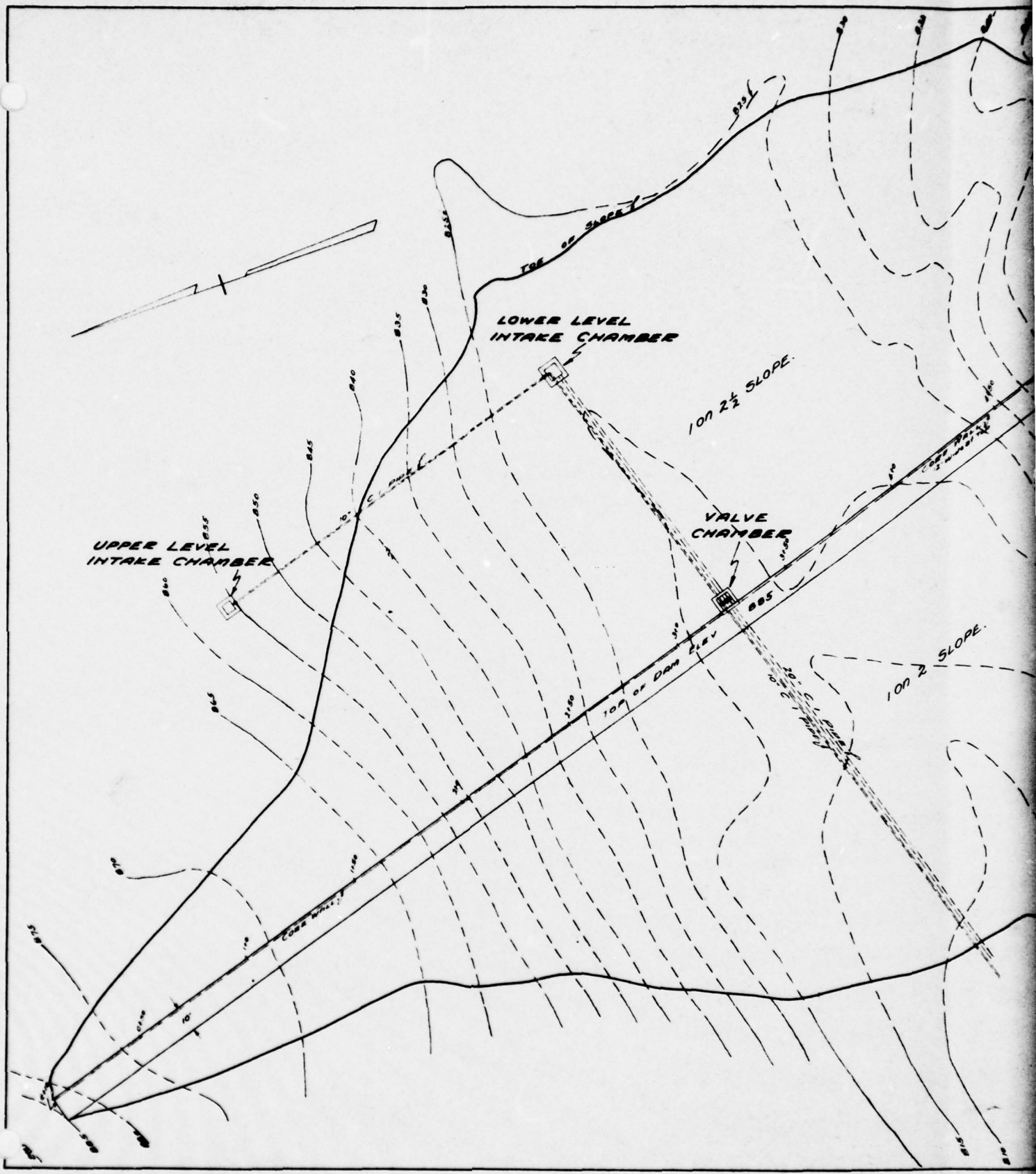
qpg - quartz plagioclase gneiss

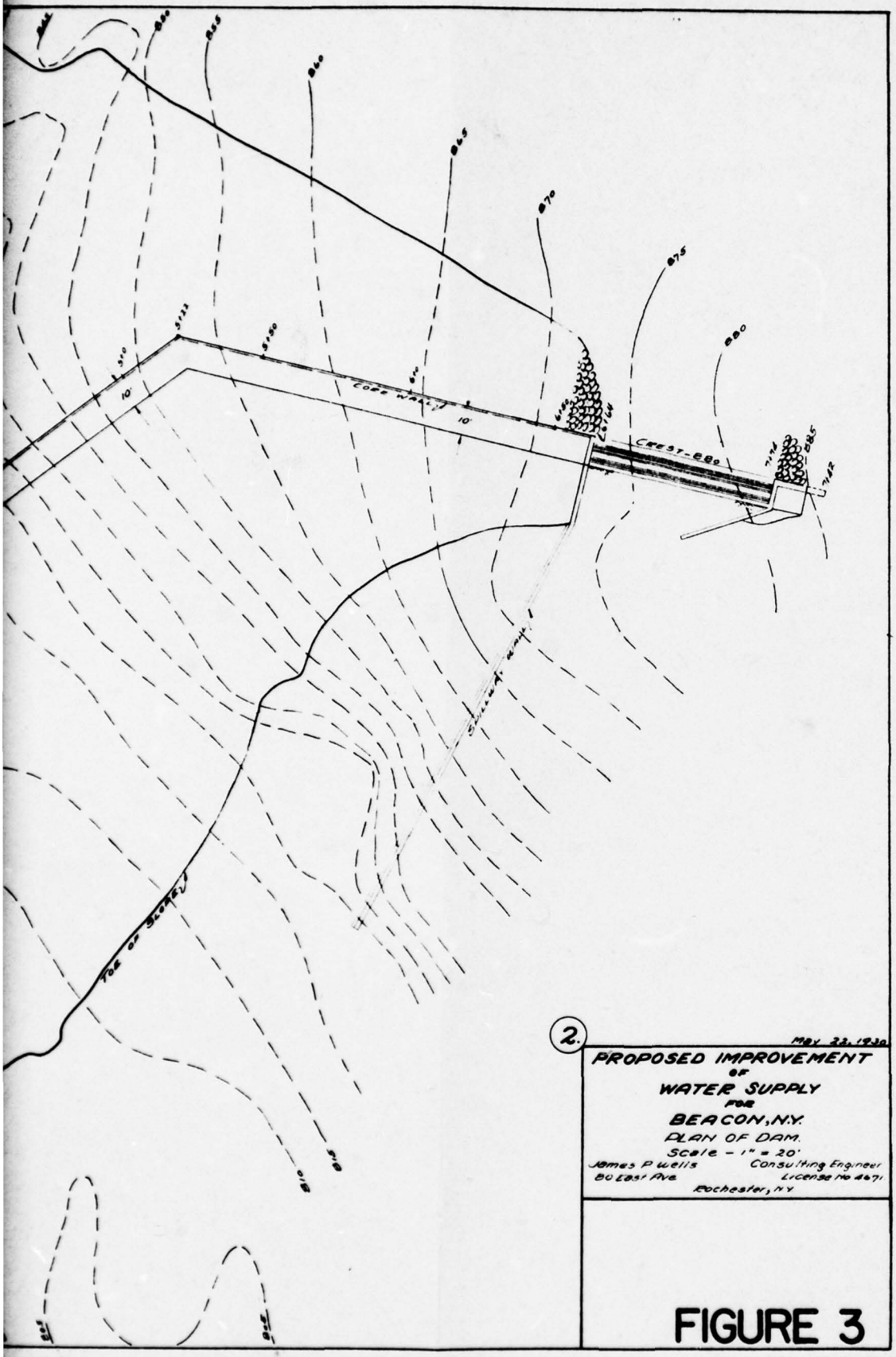
hg - hornblende, granite, granitic gneiss

Ocs - undifferentiated carbonates

Cpg - orthoquartzite

Figure 2
Geologic Map


LOWER LEVEL
INTAKE CHAMBER
UPPER LEVEL
INTAKE CHAMBER
VALVE
CHAMBER
TOE OF SLOPE
1 on 2½ SLOPE.
1 on 2 SLOPE.
TOP OF DAM ELEV
CORE WALL
CORE WALL
20' C. L. PIPE
10' C. L. PIPE
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920



2.

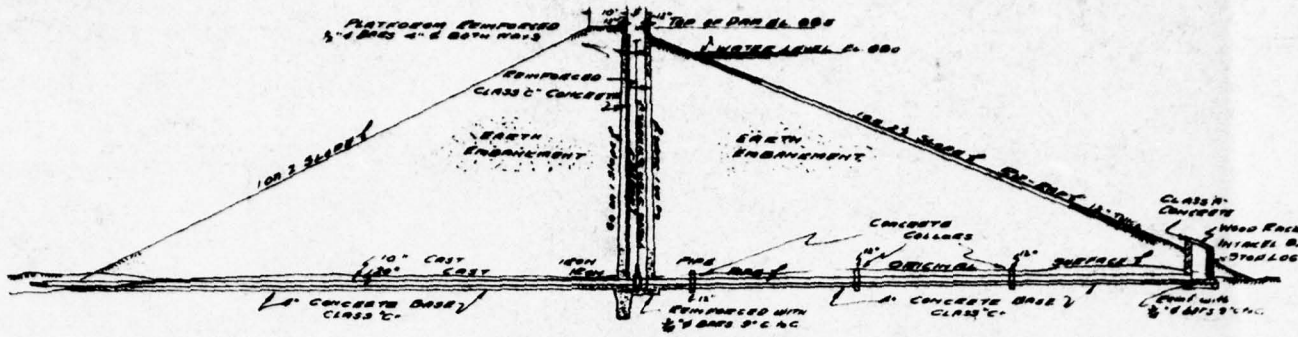
May 22, 1930

PROPOSED IMPROVEMENT
OF
WATER SUPPLY
FOR
BEACON, N.Y.
PLAN OF DAM.
Scale - 1" = 20'

James P. Wells Consulting Engineer
80 East Ave License No 4071
Rochester, N.Y.

FIGURE 3

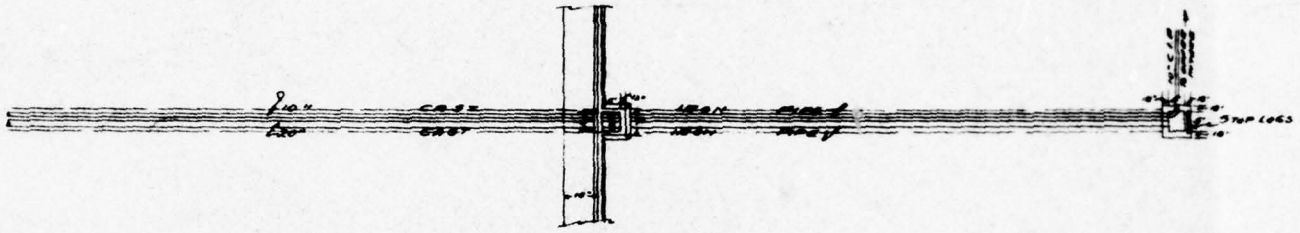
2



SECTION OF VALVE CHAMBER.

Scale - 1" = 20'

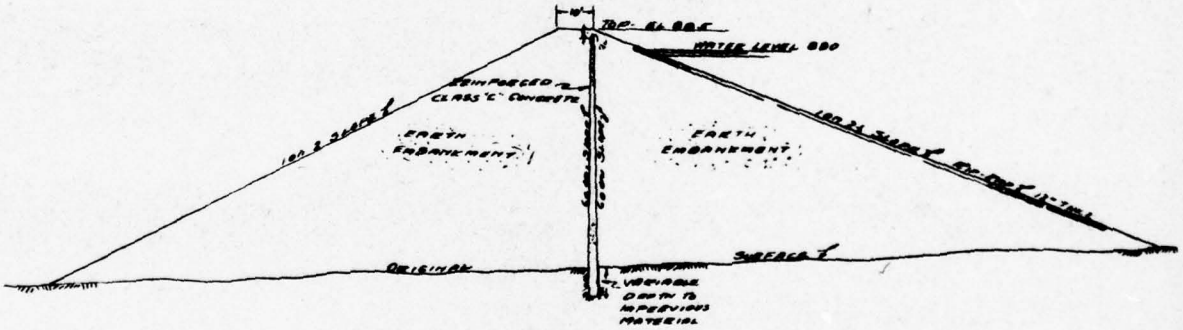
SECTION OF INTAKE CHAMBER



PLAN OF VALVE CHAMBER.

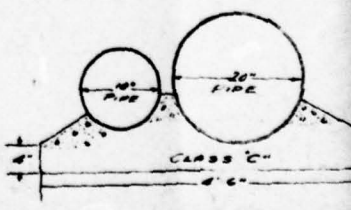
Scale - 1" = 20'

PLAN OF INTAKE CHAMBER



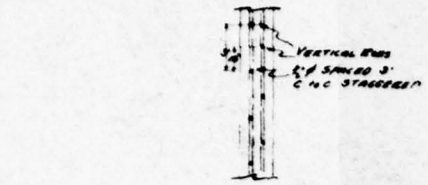
TYPICAL SECTION OF DAM.

Scale - 1" = 20'

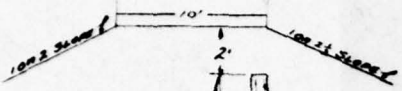


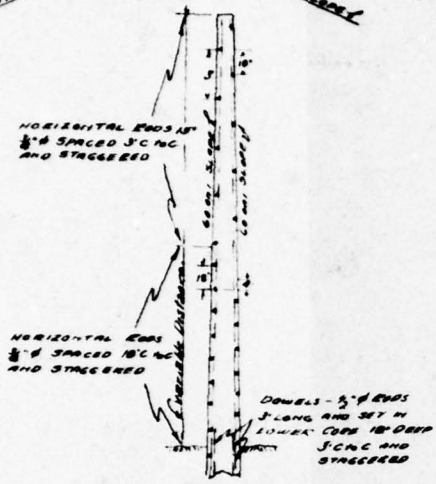
DETAIL OF BASE - 10" & 20" P

Scale - 1" = 1'

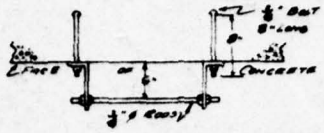


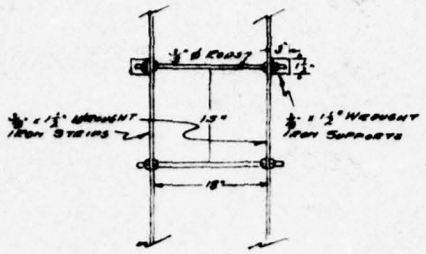
PLAN



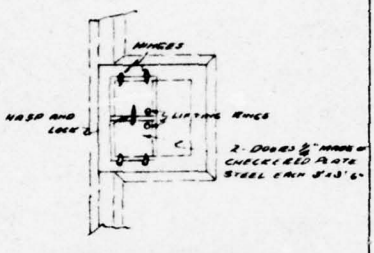


SECTION
STEEL DETAIL
CORE WALL

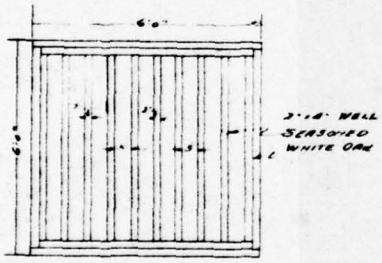




LADDER DETAIL.
Scale - 1" - 1'



VALVE CHAMBER DOORS
Scale 1" = 1'



DETAIL OF WOOD RACK
Scale - 1" = 1'

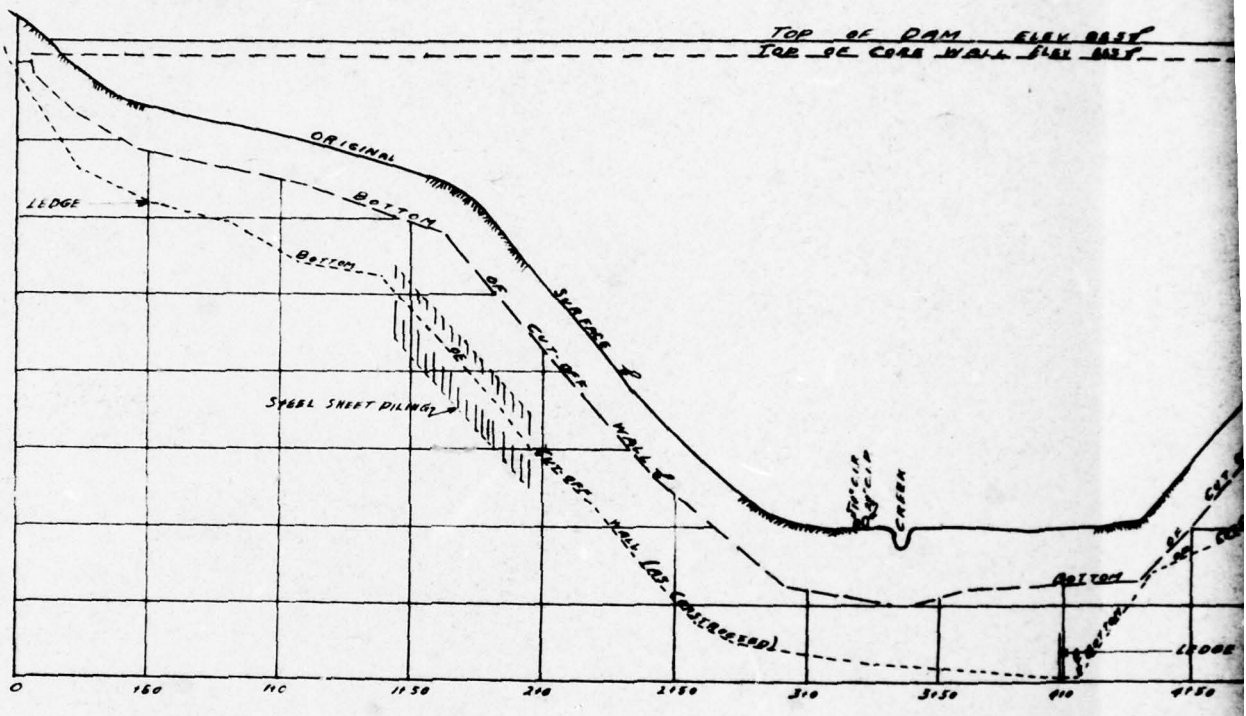
(3)

May 23, 1936

PROPOSED IMPROVEMENT
OF
WATER SUPPLY
FOR
BEACON, N. Y.
TYPICAL SECTIONS AND DETAILS.
SCALE AS INDICATED
James P. Wells — Consulting Engineer
80 East Ave, — License No. 4671.
Rochester, N.Y.

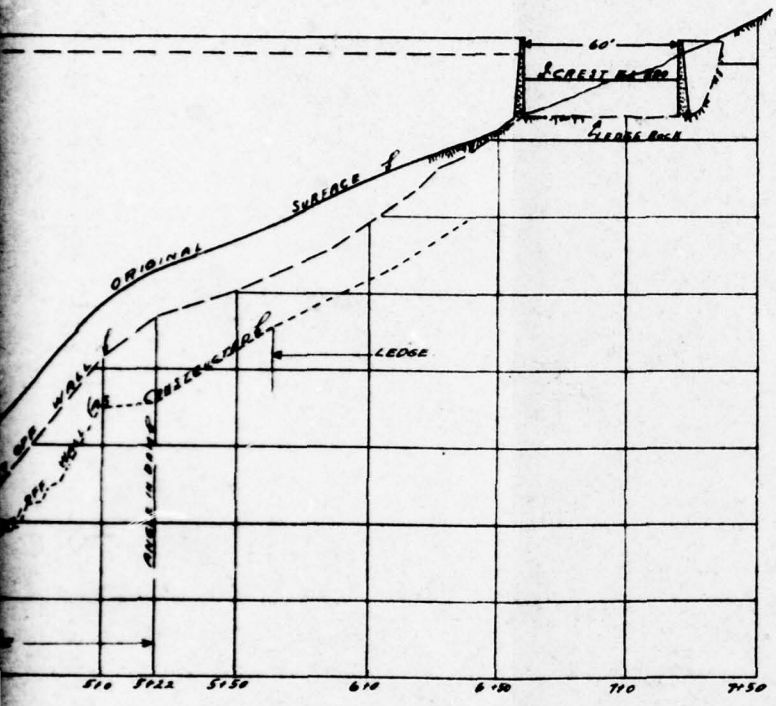
FIGURE 4

FIGURE 4



PROFILE OF DAM.
SCALE - 1" = 10' VER.
1" = 30' HOR.

Traced by Jase



(4.)

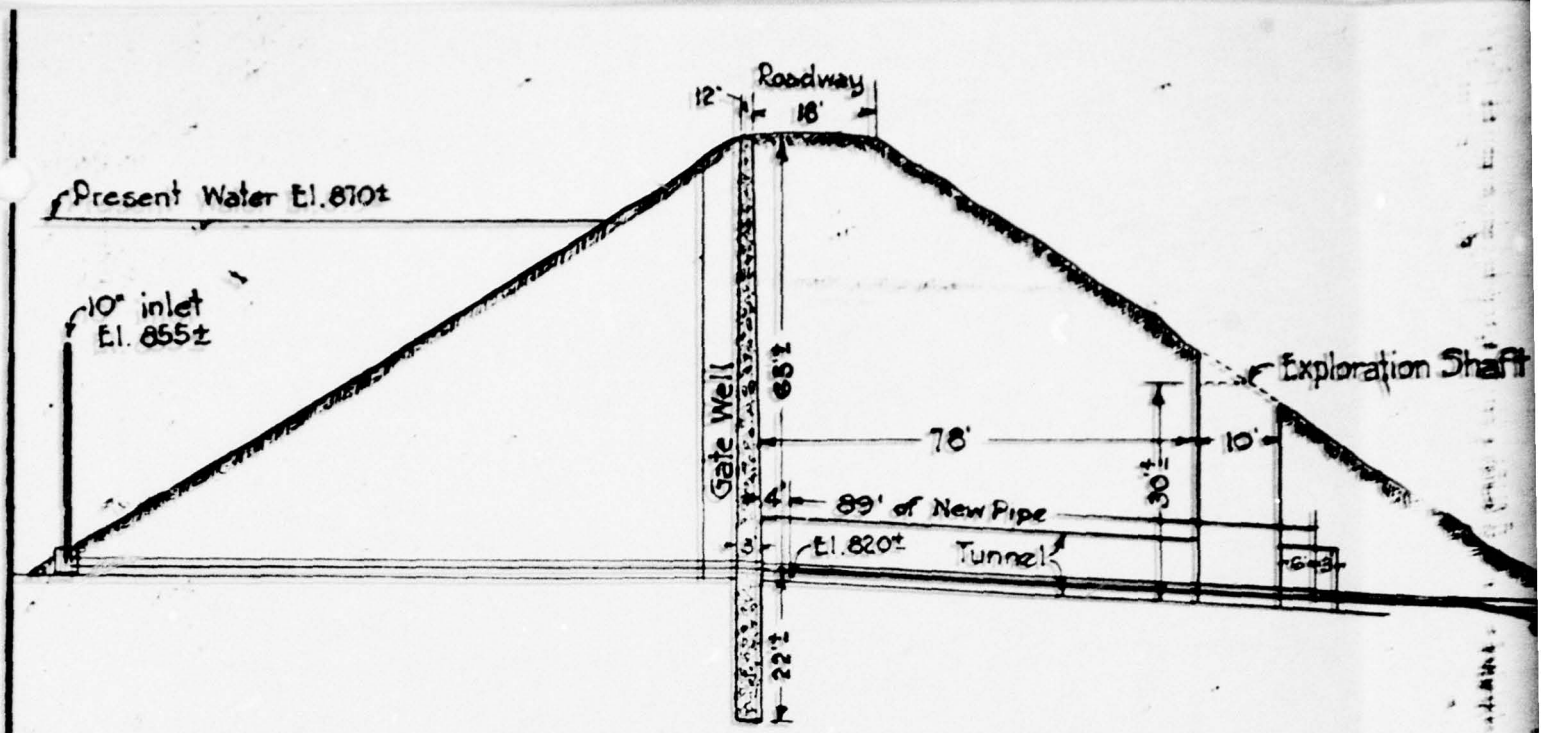
ADDITION NOV. 29, 1930
ORIGINAL MAY 22, 1930.

PROPOSED IMPROVEMENT
OF
WATER SUPPLY
FOR
BEACON, N.Y.
PROFILE OF DAM
SCALE AS INDICATED.

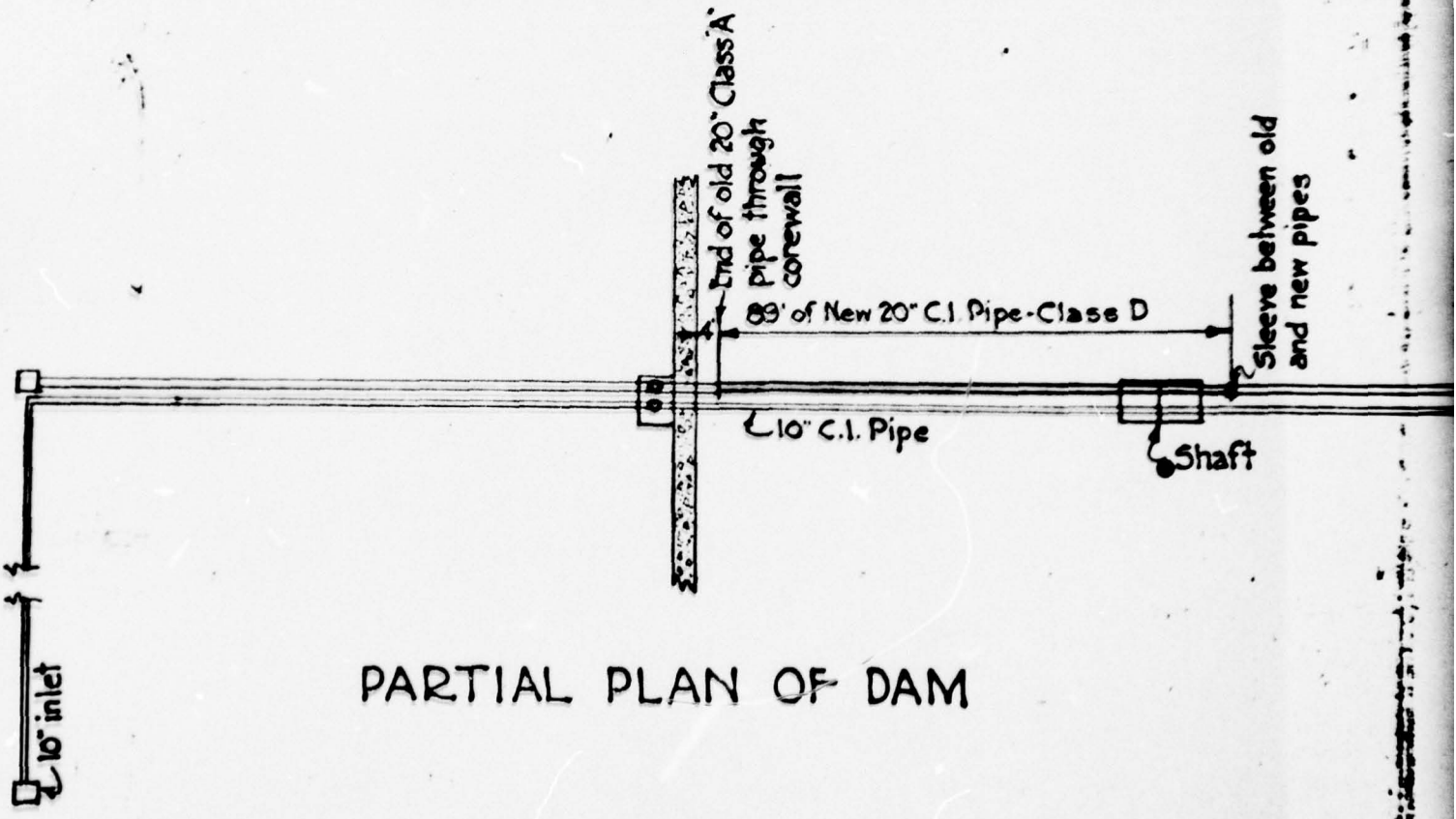
James P Wells, Consulting Engineer
80 East Ave. License No. 4671.
Rochester, N.Y.

SHOWS CORE WALL ADDITIONAL DEPTH

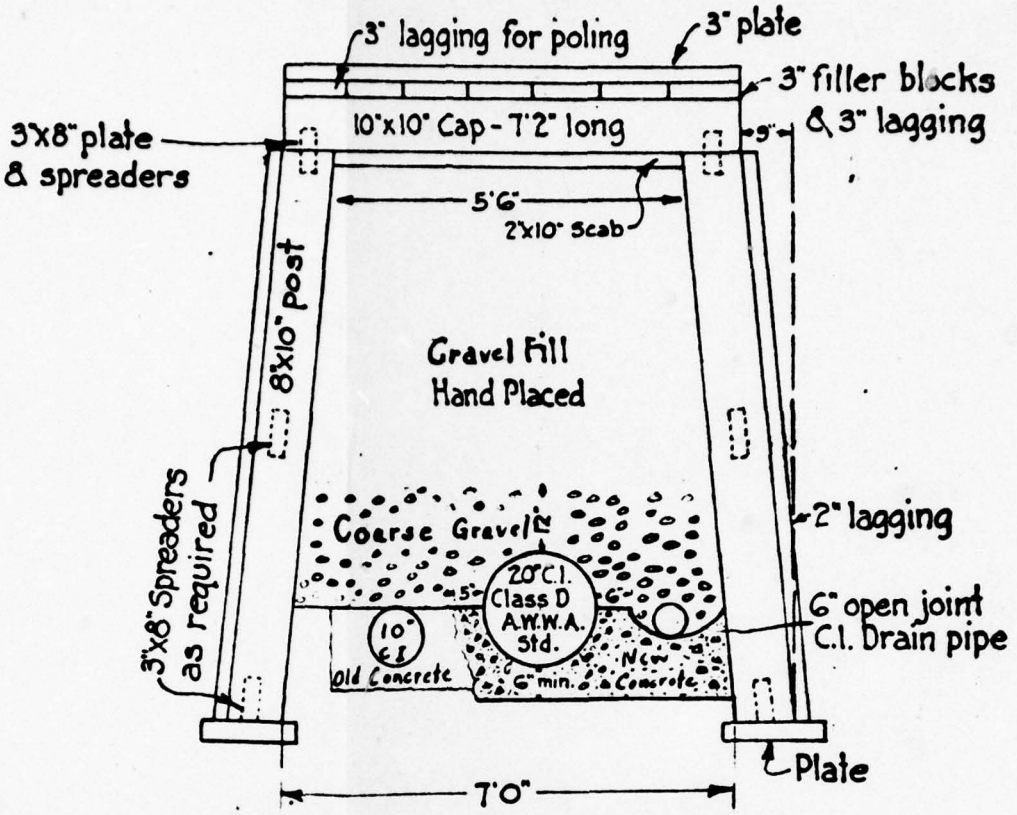
FIGURE 5



CROSS SECTION OF DAM



PARTIAL PLAN OF DAM



Bents spaced 5'0" to 6'0" o.c.

SECTION OF TUNNEL

haft

10" C.I.

Foot of slope

Gate

New gate on connection between 10" & 20" pipes

FIGURE 6

METHOD OF REPLACEMENT OF 20" C. I. PIPE AT CARGYL RESERVOIR ~~OF~~ CITY OF BEACON, N. Y.

See Original Plan by J.P. Wells, Rochester, N.Y.

Submitted by Elmer G. Hooper, Consulting Engineer, N.Y. City

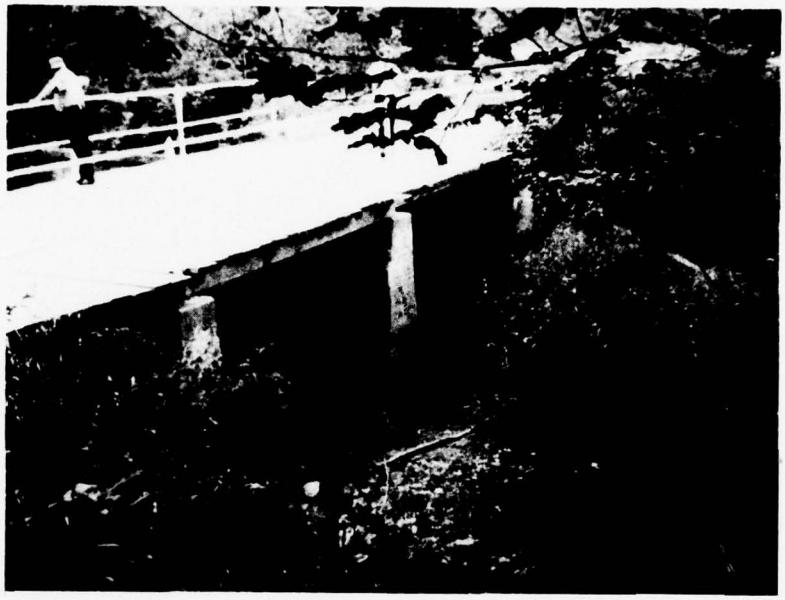
Signed Elmer G. Hooper December 8, 1931

APPENDIX

PHOTOGRAPHS

UPSTREAM SLOPE

DOWNSTREAM SLOPE



BRIDGE OVER SPILLWAY APPROACH

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Cargill Reservoir Dam County Putnam State New York Coordinators _____

Date(s) Inspection July 18, 1978 Weather Clear Temperature 85° F.

Pool Elevation at Time of Inspection 875 M.S.L. Tailwater at Time of Inspection _____ M.S.L.

Inspection Personnel:

Mr. George C. Elias

Mr. David B. Campbell

Mr. Steven H. Snider

Mr. Steven H. Snider Recorder

Accompanied by:

Mr. Seth Cabr, Department of Water Supply, Beacon, New York

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EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted	None
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted	None
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	A 60 foot long depression exists in the crest near the center of the embankment.	A study should be performed to determine the cause of this feature and if it is expanding.
RIPRAP FAILURES	None visible	None

A2

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems noted	None
ANY NOTICEABLE SEEPAGE	Discolored seepage was noted at several locations near the downstream toe.	The flow should be monitored to detect increased turbidity and a study made to determine the cause of the seepage.
STAFF GAGE AND RECORDER	N/A	
DRAINS	N/A	

A3

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	Intake chamber was submerged	None
OUTLET STRUCTURE	Outlet valve chamber was not accessable at time of inspection. City personnel noted that neither gate in the chamber has been operated in years.	20 inch gate valve should be operated to insure it is in good working order.
OUTLET CHANNEL	The Cargill Brook stream valley accepts discharge from the outlet facilities.	None
EMERGENCY GATE	A valve housed in a valve box is located below downstream toe of embankment. The valve is used to control discharge from the 20 inch diameter blow-off pipe.	None

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	No problems noted	None
APPROACH CHANNEL	The spillway approach is partially clogged with brush and debris.	This debris should be removed to avoid clogging of the bridge openings.
DISCHARGE CHANNEL	The south valley slope acts as the discharge channel; flow is guided downstream away from the embankment toe by a 180 foot long x 4 foot high concrete training wall.	Portions of the channel should be excavated to provide sufficient capacity to prevent overtopping at the training wall.
BRIDGE AND PIERS	A wooden bridge spans the spillway approach channel on two concrete piers. The concrete piers and bridge abutments are in good condition.	None

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No problems noted	None
SEDIMENTATION	None noted	None

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is very steep and narrow.	None
SLOPES	No problems noted	None
APPROXIMATE NO. OF HOMES AND POPULATION	There are about 20 private homes in the stream valley within one mile of the structure. The population is about 80.	None

ITEM	REMARKS
MONITORING SYSTEMS	Personnel from the City of Beacon operate and monitor reservoir levels and discharges.
MODIFICATIONS	The 10 inch diameter water supply line drawing water from the upper intake chamber has been abandoned. The 20 inch diameter blow-off pipe has been tapped for a 10 inch line to replace the aforementioned.
HIGH POOL RECORDS	High pool record is reported to have been about 6 inches above spillway crest. Date unknown.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	A number of inspections were made following completion in conjunction with the Dam Permit application. Included in this correspondence are discharge records from weirs constructed to measure seepage near the toe of the slope.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None noted
MAINTENANCE OPERATION RECORDS	N/A

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ITEM	REMARKS
DESIGN REPORTS	N/A
GEOLOGY REPORTS	N/A
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	N/A
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	N/A
POST-CONSTRUCTION SURVEYS OF DAM	N/A
BORROW SOURCES	Unknown

DAM CONSTRUCTION APPLICATION

2-27-29-500 (5-3147)

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

DIVISION OF ENGINEERING

ALBANY

Received May 27, 1930 Dam No. 213-871

Disposition Approved May 28, 1930 Watershed Lower Hudson

Foundation inspected

Structure inspected

Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N. Y., in compliance with the provisions of Section 948 of the Conservation Law (see last page of this application) for the approval of specifications and detailed drawings, marked Proposed Improvement of Water Supply For Beacon, N.Y. herewith submitted for the {construction / ~~reconstruction~~} of a dam herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about Feb 1, 1931 (Date)

1. The dam will be on Cargill Brook flowing into Clove Brook thence into Fishkill town of Phillipstown, County of Putnam and 3 Miles South of Fishkill on Albany Post Road (Give exact distance and direction from a well-known bridge, dam, village main cross-roads or railroad station) the 1st mile East

2. Location of dam is shown on the West Point quadrangle of the United States Geological Survey.

3. The name of the owner is City of Beacon, N.Y.

4. The address of the owner is Beacon, N.Y.

5. The dam will be used for Water Supply Purpose

6. Will any part of the dam be built upon or its pond flood any State lands? No

7. The watershed above the proposed dam is 10.2 Square Miles square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of about 25 acres and will impound 22,000,000 cubic feet of water.

9. The maximum height of the proposed dam above the bed of the stream is 65 feet ..... inches.

10. The lowest part of the natural shore of the pond is 15 feet vertically above the spillcrest, and everywhere else the shore will be at least ..... feet above the spillcrest.

11. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam Considerable damage property + life

12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) Hardpan + granite rock

13. Facing down stream, what is the nature of material composing the right bank? hardpan

14. Facing down stream, what is the nature of the material composing the left bank? hardpan + granite

15. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc. Impervious

16. Are there any porous seams or fissures beneath the foundation of the proposed dam? N

17. WASTES. The spillway of the above proposed dam will be 60 feet long in the clear; the waters will be held at the right end by an abutment the top of which will be 6 feet above the spillcrest, and have a top width of ..... feet; and at the left end by a abutment the top of which will be 5 feet above the spillcrest, and have a top width of ..... feet.

18. The spillway is designed to safely discharge 1600 cubic feet per second for height

19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows:
10" + 20"

20. What is the maximum height of flash boards which will be used on this dam? None proposed

21. APRON. Below the proposed dam there will be an apron built of [illegible] feet long across the stream, ... feet wide and ..... feet thick.

22. Does this dam constitute any part of a public water supply? Yes

INSTRUCTIONS

Read carefully on the last page of this application the law setting forth the requirements to be complied with in order to construct or reconstruct a dam.

Each application for the construction or reconstruction of a dam must be made on this standard form, copies of which will be furnished upon request to the Chief Engineer, Division of Engineering, Department of Public Works, Albany, N. Y. The application must be accompanied by three sets of plans, and specifications. The information furnished must be in sufficient detail in order that the stability and safety of the dam can be determined. In cases of large and important dams assumptions made in calculating stresses and stability should be given.

Samples of materials to be used in the dam and of the material on which the dam is to be founded may be asked for, but need not be furnished unless requested.

If the dam constitutes a part of a public water supply, application should be made to the Water Power and Control Commission under Article XI of the Conservation Law.

An application for the construction or reconstruction of a dam must be signed by the prospective owner of the dam or his duly authorized agent. The address of the signer and the date must be given as provided for on the last page of the application form.

CORRESPONDENCE

Dam Permits
L.H.#. 213-871 (City of
Beacon)
Town of Phillipstown
Putnam County

August 17th, 1932.

T. F. Farrell, Chief Engineer,
Division of Engineering,
Albany, N.Y.

Dear Sir:

On August 15th, another inspection was made of above identified dam.

Weir #	Location of Leak	Depth Flow on Weir
1	187' R of Sta. 2+24	0.50 ft.
2	190' R " " 2+54	0.35 "
3	172' R " " 3+00	0.09 "
4	167' R " " 3+24	0.05 "
5	125' R " " 3+87	0.10 "

Top elevation of lake is 873.5

Mr. Cargill who lives near the lake states that a 50 ft. interval of embankment at center of dam has been built up 3 times, each time to allow for sinkage (possibly settlement compaction) of 6 inches. See #4 our letter dated Nov. 25, 1931.

Very truly yours,

J. S. B I X B Y

District Engineer

CAH/BHI

Copy to Mr. Huhne

August 15 1932

C.A.Huhne

Poughkeepsie

As per your instructions of the 12th ist., I made observations at the Beacon City Dam this morning and foun the water 13 feet below the corewall and 6'-8" below the spillay. These measurements were made with a hand level and a 6 foot rul.

The weir readings were as follows;

#1	0.50 ft.
#2	0.35
#3	0.09
#4	0.05
#5	0.10

The road across the dam still seams to settling on the reservoir side and the man working up there td me that the road had been built up three times during the wint.

They have been fixing the road up the mtain and it is a

J. W. Quick

J. W. Quick

267 Mansion St.
Po'keepsie
N.Y.

Dam Permits
L.H... 213-871 (City of Beacon)
Town of Phillipstown
Putnam County

June 17th, 1932.

T. F. Farrell, Chief Engineer,
Division of Engineering,
Albany, N.Y.

Dear Sir:

On account of recent rains an inspection was made on June 16th of above identified dam.

Weir #	Location of Leak	Depth Flow on Weir
1	187' R of Sta. 2+24	0.25 ft.
2	190' R. of Sta. 2+54	0.40 ft.
3	172' R of Sta. 3+00	0.05 ft.
4	167' R of Sta. 3+24	0.01 ft.
5	125' R.of Sta. 3+87	0.15 ft.

Top elevation of lake now 877.5, i.e., 7½ feet below top of corewall.

Very truly yours,

J. S. B I X B Y

District Engineer

A15

CAH/ HI

Copy to Mr. C.A. Huhne

Dam Permits
L.H.W. 213-871 (City of Beacon)
Town of Phillipstown
Putnam County

June 2nd, 1932.

T. F. Farrell, Chief Engineer,
Division of Engineering,
Albany, N.Y.

Dear Sir:

On account of recent rains another inspection was made of above identified dam on May 31st

Weir #	Location of Leak	Depth Flow on Weir
1	187' R of Sta.2+34	0.25 ft.
2	190' R of Sta.2+54	0.40 ft.
3	172' R of Sta.3+00	0.05 ft.
4	167' R of Sta.3+24	0.05 ft.
5	125' R of Sta.3+87	0.22 ft.

Top elevation of lake now 876.5, i.e., 8½ feet below top o corewall.

Very truly yours,

J. S. B I X B Y

C

District Engineer

CAH/EHI

Copy to Mr. C.A. Huhne

Dam Permits: City of Beacon
L. .H.W. 213-871
To own of Phillipstown
Putnam County Putnam County

May 4th, 1932.

T. F. Farrell, Chief Engineer,
Division of Engineering,
Albany, N.Y.

Dear Sir:

Supplementing our reports of December 17th and December 29th, 1931 and January 14th, 1932, all pertaining to City of Beacon dam permit L.H.W. #213-871, Town of Phillipstown, Dutchess County, please be advised that another inspection was made on May 3rd with record as follows:-

Weir #	Location of Leak	Depth Flow On Weir	Remarks
1	187' R of Sta.2+24	0.25 ft.	Weir now takes flow from leak #1 (our letter Dec. 17-1931) and also flow from 10" C.I.P. drain to corewall (adjacent to and north of blow-off culvert) installed by Mr. Tully. No brown sedime
2	190' R of Sta.2+54	0.40 ft.	All of this flow comes from second 10" C.I.P. drain to corewall (adjacent to and south of blow-off culvert) install by Mr. Tully. Some brown precipitate. If there were a leak in the blow-off culvert valve, this weir would measure same also.
3	172' R of Sta. 3+00	0.05 ft.	Measures a leak which issues now in two separate points at downstream toe of embankment with much sulphur odor and much brown precipitate.
4	167' R of Sta. 3+24	0.05 ft.	Measures a leak which issues now in two separate points at downstream toe of embankment with much sulphur odor and much brown precipitate.
5	125' R of Sta. 3+87	0.22 ft.	Slight sulphur odor and slight brown precipitate.

Permits
#213-871
Town of Philipstown
Putnam County

January 14th, 1932.

T. F. Farrell, Chief Engineer,
Division of Engineering,
Albany, N.Y.

Dear Sir:

Inspection of new City of Beacon Dam on January 13th revealed the following:

Supt. Tully completed backfilling shaft and tunnel along blow-off culvert.

Weir	#1.	Depth of water	.05 ft.	
* "	#2.	" " "	.17 "	(much brownish yellow material)
"	#3.	" " "	.05 "	(" " " " ")
"	#4	" " "	.01 "	
"	#5	" " "	.01 "	

Surface elevation of water in lake = 859.5 (assumed datum as in our letter dated December 17th).

Kindly refer to fourth paragraph of our letter dated December 29th in which we stated that top elevation of water in lake was 825.6 . This was incorrect by 30 feet as the water elevation was 855.6 at that time.

Very truly yours,

J. S. B I X B Y

District Engineer

CAH/BHI

Copy to C.Reuther: You used datum of 855 for top corewall, though our letter of Dec. 4th distinctly told you to use 885.0.

JSB

" " Mr. C.A.Huhne

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HYDROLOGIC/HYDRAULIC CALCULATIONS

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 1 OF
DATE 8/1/78
NAME OF CLIENT NYSDEC
COMP. BY DBC
PROJECT Beacon Reservoir
CHECKED BY REH

Time of Concentration

#1 BPR

$$T_c = \left(\frac{11.9\,L^3}{H}\right)^{.385}$$

L = 1.10 miles
H = 248 ft

$$T_c = \left(\frac{11.9 \times 1.1^3}{248}\right)^{.385} = .35 \text{ hrs.}$$

#2 SCS CURVE NUMBER

$$L = \frac{l^{.8} \times (S+1)^{.7}}{1900\, Y^{.5}} \qquad T_c = \frac{L}{.6}$$

$l = 5800'$

$S = \frac{1000}{60} - 10 = 6.67$

$Y = 9.9\%$

$L = .71$ hrs. $T_c = 1.2$ hrs ← use

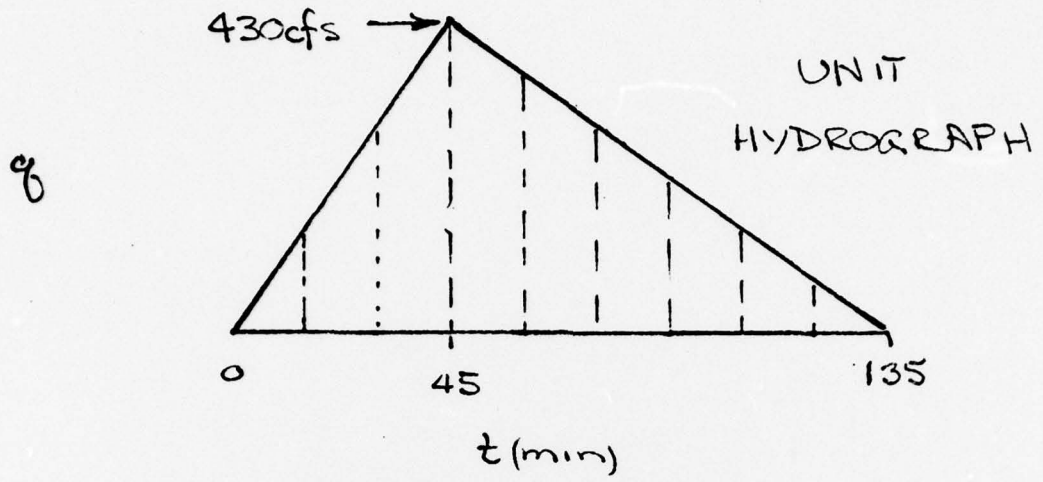
use $D = .25$ hrs.

$t_p = D/2 + .6T_c = .85$ hrs ≈ 50 min. Use 45 min

$$q_p = \frac{DA \times 5280^2/12}{t_b/2 \times 3600}$$

$t_b = 2.67\, t_p \simeq 2.25$ hrs

$$q_p = \frac{.75 \times 5280^2/12}{\frac{2.25}{2} \times 3600} = 430 \text{ cfs}$$



t(min)	q(cfs)
0	0
15	143
30	287
45	430
60	358
75	287
90	215
105	143
120	72
135	0

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 3 OF _____
DATE 8/1/78
COMP. BY DBC
CHECKED BY REH

NAME OF CLIENT NYSDEC
PROJECT Beacon Reservior

6 hr. PMP = 24"

DA. = .75 sq. miles

reduction factor for "probable misfit" of storm isohyetals and basin = 20%

PMP = 19.2"

Time (hrs)	Σ PMP	Δ	Third Quartile
1	9.4	9.4	1.5
2	12.3	2.9	1.7
3	14.4	2.1	2.1
4	16.1	1.7	9.4
5	17.7	1.6	2.9
6	19.2	1.5	1.6

Storage @ normal pool (El. 880) = 505 acre-ft

Surface Area @ normal pool = 25 acres

Surface Area @ El 885 = 32 acres (approx)

Assume area varies linearly with height above spillway crest

$A = 1.4H + 25$ & Surcharge Storage $(S) = \int 1.4H + 25$

$S = .7H^2 + 25H + C^0$

Stage - Storage Relation

Elevation	H(ft)	Storage (acre-ft)
880	0	0
881	1	25.7
882	2	52.8
883	3	81.3
884	4	111.2
885	5	142.5
886	6	175.2
887	7	209.3

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

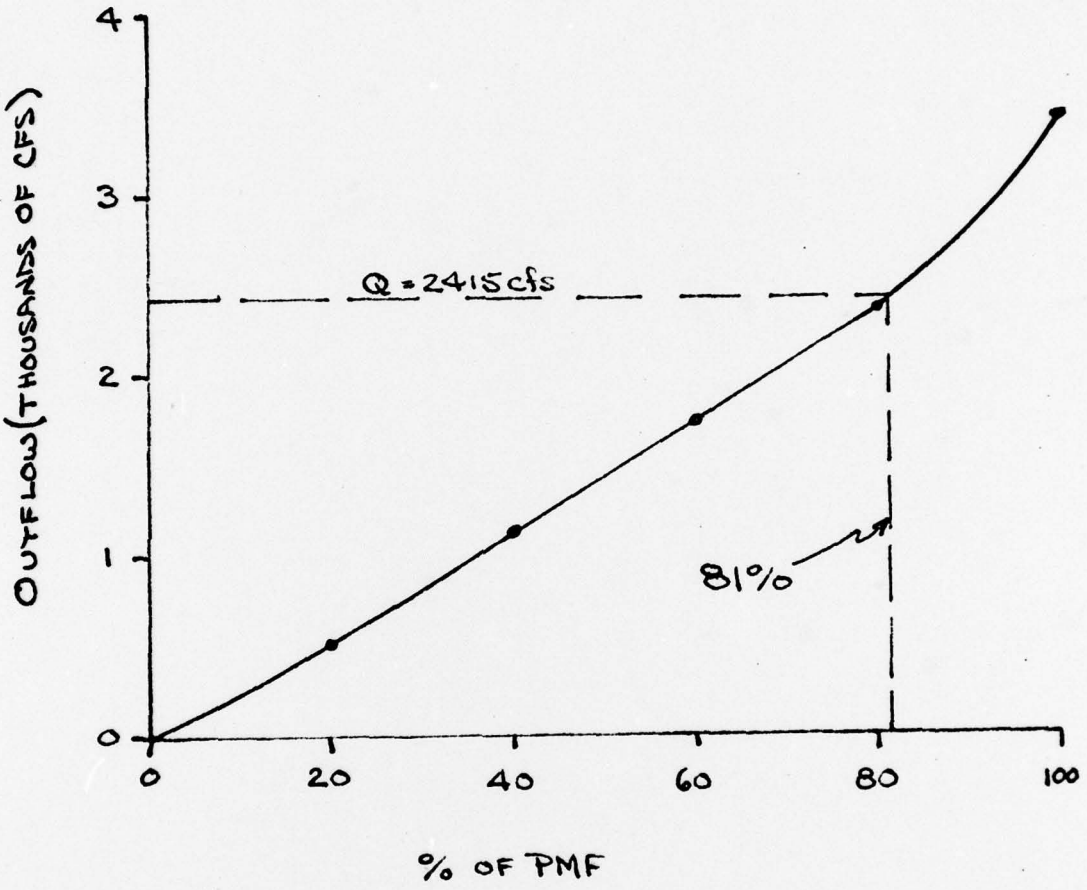
SHEET NO. 5 OF ____
DATE 8/2/18
COMP. BY DBC
CHECKED BY REH

NAME OF CLIENT NYSDEC
PROJECT Beacon Reservoir

Spillway crest @ El. 880
Spillway length ≈ 60'
$Q_S = 3.6 \times 60 \times H^{3/2}$

Top of dam @ El 885
Length of Dam = 665'
$Q_{OT} = 3.1 \times 665 \times (H-5)^{3/2}$

Elevation	H	Q_S	Q_{OT}	ΣQ
880	0	0	0	0
881	1	216	0	216
882	2	611	0	611
883	3	1122	0	1122
884	4	1728	0	1728
885	5	2415	0	2415
886	6	3175	2062	5237
887	7	4000	5831	9831


OUTFLOW (THOUSANDS OF CFS)
4
3
2
1
0
Q = 2415 cfs
81%
0
20
40
60
80
100
% OF PMF

****
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
****

NATIONAL DAM INSPECTION PROGRAM
BEACON RESERVOIR DAM
PMF HYDROGRAPH

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
50	0	15	1	0	0	0	0	0	0

JOPER	NMT
5	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RTIOS= .20 .40 .60 .80 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	.75	0.00	0.00	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
24	0.00	0.00	0.00

PRECIP PATTERN

.30	.40	.40	.40	.40	.40	.40	.50	.50	.50
.50	.60	2.30	2.30	2.40	2.40	.80	.70	.70	.70
.40	.40	.40	.40						

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	0.00	.10	0.00	0.00

GIVEN UNIT GRAPH, NUHGO= 10

0.	143.	287.	430.	358.	287.	215.	143.	72.	0.

UNIT GRAPH TOTALS 1935. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	0 15	.30	.28	0.
1	0 30	.40	.38	39.
1	0 45	.40	.38	133.
1	0 60	.40	.38	280.
1	1 15	.40	.38	421.
1	1 30	.40	.38	536.

1	2	15	.50	.48	733.
1	2	30	.50	.48	769.
1	2	45	.50	.48	812.
1	2	60	.60	.58	867.
1	3	15	2.30	2.28	890.
1	3	30	2.30	2.28	1184.
1	3	45	2.40	2.38	1729.
1	3	60	2.40	2.38	2517.
1	4	15	.80	.78	3183.
1	4	30	.70	.68	3507.
1	4	45	.70	.68	3443.
1	4	60	.70	.68	3011.
1	5	15	.40	.38	2539.
1	5	30	.40	.38	2015.
1	5	45	.40	.38	1564.
1	5	60	.40	.38	1185.
1	6	15	0.00	0.00	940.
1	6	30	0.00	0.00	801.
1	6	45	0.00	0.00	629.
1	6	60	0.00	0.00	425.
1	7	15	0.00	0.00	269.
1	7	30	0.00	0.00	161.
1	7	45	0.00	0.00	81.
1	7	60	0.00	0.00	27.
1	8	15	0.00	0.00	0.
1	8	30	0.00	0.00	0.
1	8	45	0.00	0.00	0.
1	8	60	0.00	0.00	0.
1	9	15	0.00	0.00	0.
1	9	30	0.00	0.00	0.
1	9	45	0.00	0.00	0.
1	9	60	0.00	0.00	0.
1	10	15	0.00	0.00	0.
1	10	30	0.00	0.00	0.
1	10	45	0.00	0.00	0.
1	10	60	0.00	0.00	0.
1	11	15	0.00	0.00	0.
1	11	30	0.00	0.00	0.
1	11	45	0.00	0.00	0.
1	11	60	0.00	0.00	0.
1	12	15	0.00	0.00	0.
1	12	30	0.00	0.00	0.
		SUM	19.20	18.61	35993.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3507.	1458.	720.	720.	35991.
INCHES		18.09	18.60	18.60	18.60
AC-FT		724.	744.	744.	744.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

0.	8.	27.	56.	84.	107.	125.	137.	147.	154.
162.	169.	178.	237.	346.	503.	637.	701.	690.	602.
508.	403.	313.	237.	190.	160.	126.	85.	54.	32.
15.	5.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	701.	292.	144.	144.	7198.
INCHES		3.62	3.72	3.72	3.72
AC-FT		145.	149.	149.	149.

32.	11.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1403.	583.	288.	288.	14396.
INCHES		7.24	7.44	7.44	7.44
AC-FT		289.	298.	298.	298.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

0.	24.	80.	168.	253.	321.	374.	411.	440.	461.
487.	508.	534.	710.	1037.	1510.	1910.	2104.	2069.	1807.
1524.	1209.	938.	711.	569.	481.	377.	255.	161.	97.
48.	16.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2104.	875.	432.	432.	21595.
INCHES		10.85	11.16	11.16	11.16
AC-FT		434.	446.	446.	446.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

0.	31.	106.	224.	337.	429.	499.	547.	586.	615.
649.	678.	712.	947.	1383.	2014.	2547.	2805.	2759.	2409.
2031.	1613.	1251.	948.	758.	641.	503.	340.	215.	129.
65.	22.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2805.	1167.	576.	576.	28793.
INCHES		14.47	14.88	14.88	14.88
AC-FT		579.	595.	595.	595.

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HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

0.	39.	133.	280.	421.	536.	623.	684.	733.	769.
812.	847.	890.	1184.	1729.	2517.	3183.	3507.	3449.	3011.
2539.	2016.	1564.	1185.	948.	801.	629.	425.	269.	161.
81.	27.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3507.	1458.	720.	720.	35991.
INCHES		18.09	18.60	18.60	18.60
AC-FT		724.	744.	744.	744.

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	1

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	26.	53.	81.	111.	143.	175.	209.	0.	0.
OUTFLOW=	0.	216.	611.	1122.	1720.	2415.	5237.	9831.	0.	0.

STOR

0.	0.	0.	1.	2.	4.	5.	7.	9.	10.
1.	13.	14.	16.	19.	24.	31.	37.	43.	46.
47.	46.	43.	40.	36.	32.	29.	26.	23.	21.
18.	15.	13.	11.	9.	8.	6.	5.	4.	4.
3.	3.	2.	2.	2.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	525.	267.	143.	143.	7169.
INCHES		3.31	3.70	3.70	3.70
AC-FT		132.	148.	148.	148.

STATION 2, PLAN 1, RTIO 2

0.	1.	7.	19.	38.	63.	90.	117.	144.	169.
192.	215.	248.	292.	368.	494.	673.	881.	1040.	1119.
1116.	1052.	947.	823.	699.	593.	513.	434.	357.	286.
224.	188.	159.	134.	112.	94.	79.	67.	56.	47.
40.	33.	28.	23.	20.	17.	14.	12.	10.	8.

STOR

0.	0.	1.	2.	5.	7.	11.	14.	17.	20.
23.	26.	28.	31.	36.	45.	56.	68.	77.	81.
81.	77.	72.	65.	58.	52.	46.	41.	35.	30.
26.	22.	19.	16.	13.	11.	9.	8.	7.	6.
5.	4.	3.	3.	2.	2.	2.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1119.	545.	287.	287.	14353.
INCHES		6.76	7.42	7.42	7.42
AC-FT		270.	297.	297.	297.

STATION 2, PLAN 1, RTIO 3

0.	2.	10.	28.	57.	94.	134.	176.	215.	277.
329.	373.	412.	467.	573.	785.	1074.	1392.	1633.	1739.
1713.	1593.	1413.	1209.	1023.	867.	730.	602.	499.	402.
316.	242.	194.	163.	137.	115.	97.	81.	68.	57.
48.	41.	34.	29.	24.	20.	17.	14.	12.	10.

STOR

0.	0.	1.	3.	7.	11.	16.	21.	26.	30.
33.	36.	39.	43.	50.	62.	79.	95.	106.	112.
110.	105.	96.	86.	76.	67.	59.	52.	45.	38.
33.	27.	23.	19.	16.	14.	12.	10.	8.	7.
6.	5.	4.	3.	3.	2.	2.	2.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1739.	828.	431.	431.	21542.
INCHES		10.27	11.13	11.13	11.13
AC-FT		411.	445.	445.	445.

STATION 2, PLAN 1, RTIO 4

0.	3.	13.	37.	76.	125.	179.	246.	330.	401.
461.	514.	562.	636.	801.	1082.	1492.	1914.	2235.	2364.
2311.	2130.	1872.	1595.	1338.	1118.	947.	783.	625.	504.
397.	305.	228.	187.	157.	132.	111.	93.	78.	66.
55.	46.	39.	33.	28.	23.	19.	16.	14.	12.

STOR

0.	0.	2.	4.	9.	15.	21.	28.	34.	38.
43.	46.	49.	54.	63.	79.	100.	120.	134.	140.
138.	130.	118.	105.	92.	81.	72.	62.	54.	45.
38.	32.	27.	22.	19.	16.	13.	11.	9.	8.
7.	6.	5.	4.	3.	3.	2.	2.	2.	1.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	2364.	1113.	575.	575.	28732.
	INCHES		13.81	14.85	14.85	14.85
	AC-FT		552.	594.	594.	594.

STATION 2, PLAN 1, RTIO 5

0.	3.	16.	47.	95.	156.	229.	340.	437.	519.
590.	661.	726.	823.	1021.	1392.	1908.	2477.	3420.	3241.
2802.	2373.	2157.	1068.	1582.	1337.	1121.	936.	752.	588.
466.	358.	268.	205.	172.	145.	122.	102.	86.	72.
61.	51.	43.	36.	30.	25.	21.	18.	15.	13.

STOR

0.	0.	2.	6.	11.	19.	27.	34.	41.	46.
51.	56.	59.	65.	76.	95.	119.	143.	154.	152.
147.	141.	131.	118.	104.	92.	81.	71.	61.	51.
43.	35.	29.	24.	20.	17.	14.	12.	10.	9.
7.	6.	5.	4.	4.	3.	3.	2.	2.	2.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	3420.	1398.	718.	718.	35925.
	INCHES		17.34	18.57	18.57	18.57
	AC-FT		694.	743.	743.	743.

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PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS				
OPERATION	STATION	PLAN	.20	.40	.60	.80	1.00
HYDROGRAPH AT	1	1	701.	1403.	2104.	2805.	3507.
		2	0.	0.	0.	0.	0.
ROUTED TO	2	1	525.	1119.	1739.	2364.	3420.
		2	0.	0.	0.	0.	0.